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RESERVE

Fiscal Year 1965

Summary Report of
**UTILIZATION RESEARCH
and DEVELOPMENT**

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Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

Washington, D.C. January 1966

CONGRESSIONAL DIRECTIVE

This report is submitted in further response to the request made by the Committee on Appropriations in its report to the Senate on the Agricultural and Farm Credit Administration Appropriation Bill, 1960 (Report No. 330). This request, on page 4, paragraph 3 of the report under section entitled "Utilization Research," states:

"Further, the committee specifically requests that it be kept advised by an annual summary report on research developments, including the work in progress at these laboratories, proposed new work, and on projects to be discontinued due to completion of work or lack of results with the reasons for discontinuance. It is the hope of the committee that it will be kept better advised not only as to the specific accomplishments in the field of utilization research but also as to fiscal requirements at these installations."

Previous reports concerning the utilization research activities of the Department, made in compliance with this request, have been submitted for Fiscal Years 1959, 1960, 1961, 1962, 1963, and 1964.

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UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service

SUMMARY REPORT OF UTILIZATION RESEARCH AND DEVELOPMENT

Fiscal Year 1965

I NATURE AND OPERATION OF UTILIZATION RESEARCH

The Department's Utilization Research and Development is a part of the Nutrition, Consumer and Industrial Use Research, a major segment of the Agricultural Research Service. Utilization research is directed to the expansion of agricultural markets and reduction of processing and distribution costs, thus increasing farm income and consumers' welfare and reducing excessive carry-over of farm commodities. These UR&D efforts go across the entire horizon of agricultural commodities -- food, feed, fiber, and industrial products. These objectives are accomplished by developing new and improved agricultural products and economic methods for their manufacture through basic and applied work in chemistry, physics, engineering, and related sciences.

The Department's utilization research investigations in Fiscal Year 1965 were conducted primarily in Federal facilities consisting of four regional laboratories (Albany, Calif.; Peoria, Ill.; New Orleans, La.; and Wyndmoor, Pa.), and eleven field stations (Beltsville, Md.; Washington, D. C.; Olustee and Winter Haven, Fla.; Houma, La.; Raleigh, N. C.; Weslaco, Tex.; Pasadena, Calif.; Honolulu, Hawaii; and Prosser and Puyallup, Wash.) in the United States. Research is done also through contracts, grants, and memoranda of understanding with State Experiment Stations, universities, and industry. Other supporting research is accomplished in research institutions of twenty countries in Europe (12), Asia (4), South America (3), and Australia (1), through funds generated by the P. L. 480 program (Agricultural Trade and Development and Assistance Act of 1954, 83rd Congress, 2nd Session).

II MAKING UTILIZATION RESEARCH INFORMATION AVAILABLE

Making utilization research information effectively available is one of the most challenging problems. During F. Y. 1965 efforts were intensified to make the scientific knowledge developed in the Utilization Research and Development laboratories more available to groups throughout this country and abroad who could profit by this new knowledge. More effort was made to make the information understandable to the particular groups concerned. The F. Y. 1965 dissemination efforts may be summarized as follows:

- 72 patents obtained
- 835 research papers published
- 894 speeches, press releases, and appearances
on radio and television
- 57 formal conferences with industry
- 25 public-service exhibits
- 7,600 technical visitors to UR&D installations

Rural Areas Development Program

The Utilization Research and Development participation in the Rural Areas Development program was substantially expanded beyond the contributions made the prior year (F.Y. 1964). During F. Y. 1965, active assistance was given 64 rural communities in 27 states to consider 79 types of processing plants and to discuss over-all opportunities for manufacturing food, feed, fiber, and industrial products in the particular community. Sixty-five formal presentations were made to Federal, state, and local groups concerning principles of plant establishment and operation, available UR&D assistance, processing opportunities in the fields of food, feed, fiber, and industrial products, and needed facilities and services for each particular processing project. Comparatively, in F. Y. 1964, 33 formal presentations were made to groups in 12 states concerning agricultural processing operations. To date, UR&D assistance has been given to rural communities in 41 states.

The writing has continued of brochures that give summarized technical and economic information pertinent to processing specific agricultural commodities. These brochures are providing valuable guidelines to communities considering such processing possibilities.

A number of Indian groups were helped, especially in Montana, New Mexico, North Carolina, and Florida. These groups were interested principally in establishing sewing centers which would take advantage of two recent Department developments -- flame-resistant cotton items and glutaraldehyde-tanned leathers for garments.

Cooperative assistance with the Office of Economic Opportunity has been directed to alleviate poverty conditions in predominately Negro communities through better processing methods and facilities suitable for use by small groups to preserve home-grown fruits, vegetables, poultry, and meats.

Conferences have been held to consider additional agricultural processing in the Upper Great Lakes Region (Minnesota-Michigan-Wisconsin). All 12 states in the Appalachian region have been actively helped toward establishing new processing plants or improvement of existing ones. Sixteen agricultural processing plant proposals have been cooperatively evaluated with the Area Redevelopment Administration (now known as the Economic Development Administration). Intensive follow-up assistance in agricultural processing has been given in Florida, Kentucky, Louisiana, Michigan, Montana, New Mexico, North Carolina, Oregon, Texas, and Washington.

Continuing liaison has been maintained with (a) USDA agencies concerned in the RAD program (Rural Community Development Service, Farmers Home Administration, Farmers Cooperative Service, Soil Conservation Service, Federal Extension Service, Rural Electrification Administration, Cooperative State Research Service); (b) RAD Boards and Technical Action Panels in the States; (c) the Area Redevelopment Administration (now known as the Economic Development Administration); and (d) the Small Business Administration.

In F. Y. 1965, UR&D assisted in the feasibility evaluation or plant planning for the following proposed agricultural processing plants:

Fruit and vegetable products.	34
Cereal grain and feed products.	13
Cotton, wool, and leather products.	7
Oilseed products.	6
Special Crops (sorghum and maple sirups; pine-gum products).	7
Poultry, dairy, and animal products	11
Processed food products	<u>1</u>
Total	79

Utilization Research Illustrative Materials

In F. Y. 1965, UR&D prepared and displayed a number of special exhibits concerning various phases of the efforts to develop new farm products. Illustrative examples are:

Group Concerned	Subject	Location
Utah State University (Extension Service activities)	Wool garments treated for shrink resistance	Logan, Utah
Michigan State University (Extension Service activities)	UR&D dehydrated food products	East Lansing, Michigan
American Hospital Association	Flame-resistant cotton	San Francisco, California; Chicago, Illinois
American Chemical Society (Chemical Trail Blazers Exhibit)	Fire-retardant coatings; new oilseed crops; rigid starch foams	Chicago, Illinois
Louisiana State Fair	Sweetpotato products	Shreveport, Louisiana
Mississippi-Alabama Fair and Dairy Show	New and improved cotton fabrics	Tupelo, Mississippi
South Carolina State Fair	Cotton batting	Clemson, South Carolina
Eastern Utilization Open-House Show	23 exhibits of UR&D food, feed, fiber and industrial products	Wyndmoor, Pennsylvania
University of Vermont (Consumer Days Exhibition)	Eastern Division developed food products	Burlington, Vermont
East-South Regional Restaurant Convention	Explosion-puffed fruit and vegetable products	Washington, D. C.

Formal Conferences with Industry and Other Outside Organizations

Fifty-seven formal conferences were sponsored by UR&D laboratories with industry and other organizations. The following examples are typical of the kinds of groups and attendance:

Conference	Sponsors	Attendance	Location
EMA Research and Development Council and EU Workshop (October 15, 1964)	EU: EMA Research and Development Council	45	Wyndmoor, Pennsylvania
Eastern Agricultural Experiment Stations Collaborators' Conference on Post Harvest Physiology (October 27&28, 1964)	EU; Eastern Agricultural Experiment Stations	74	Wyndmoor, Pennsylvania
Tobacco Research Advisory Council (February 24, 1965)	EU; Tobacco Research Advisory Council	26	Philadelphia, Pennsylvania
Committee on Agricultural Science (May 24&25, 1965)	EU; Committee on Agricultural Science	29	Philadelphia, Pennsylvania
Soybean Research Council of the National Soybean Processors Association (March 17&18, 1965)	NU; Soybean Research Council of NSPA	16	Peoria, Illinois
11th Annual Joint Conference of Cooperative Soybean-Cottonseed Mills (March 1&2, 1965)	NU; SU; soybean and cottonseed oil mills	243	Washington, D. C.
Third National Wheat Utilization Research Conference (November 5-7, 1964)	NU; WU; USDA; Kansas State University; Great Plains Wheat, Inc.; Western Wheat Associates; National Association of Wheat Growers	170	Manhattan, Kansas
Tung Research Meeting (August 1, 1964)	SU; Pan-Am Tung Oil Association	13	Hattiesburg, Mississippi

Formal Conferences with Industry and Other Outside Organizations (cont'd)

Conference	Sponsors	Attendance	Location
1964 Technical Session on Cane Sugar Refining Research (November 9&10, 1964)	SU; cane sugar industry	59	New Orleans, Louisiana
Dry Bean Conference (December 3-5, 1964)	WU; USDA; National Dry Bean Council; State Agricultural Stations; regional trade associations	100	Ithaca and Geneva, New York
Civil Defense Rations Research (May 21, 1965)	WU; civil defense contractors; Stanford Research Institute; U. S. Army	20	Kansas City, Missouri
Institute of American Poultry Industries Research Council Meeting (June 15, 1965)	WU; IAPI Research Council; PDPA Scientific Advisory Committee	70	Albany, California
Northwest Cannery & Freezers Association (Jan. 11&12, 1965)	WU; Northwest Cannery & Freezers Associa- tion; State Experi- ment Stations	1,000	Portland, Oregon

III COOPERATIVE RESEARCH WITH OTHER ORGANIZATIONS

Increasing emphasis is being placed on cooperative work with other groups to develop and evaluate new products, to devise economic processes for product manufacture, and to explore new outlets for agricultural products. Such cooperative efforts shorten the time of achievement and accelerate commercialization considerations. Examples of cooperative research and development are:

Project	Cooperators with USDA UR&D
Processing characteristics of new potato varieties	Red River Valley Potato Growers Association; University of Minnesota; North Dakota State University
Evaluation of crambe oil as mold lubricant for continuous casting of steel	McLouth Steel Company
Full-fat soy flours for developing countries	Agency for International Development
New insect resistant cotton bags for cereal food storage and shipment	Textile Bag Manufacturers Association; bag manufacturers; Stored Products Insect Branch, ARS
Cottonseed and peanut flours for human consumption	Agency for International Development
Control of <u>Salmonella</u> in egg products by new USDA pasteurization method	Commercial egg processors in Kansas, California, Illinois, Missouri, and Washington
Improved products from dried fruits	Dried Fruit Cooperators (California Raisin Advisory Board; Dried Fig Advisory Board; Prune Advisory Board; and Dried Fruit Association of California)
Evaluation of WURLD wheat for humanitarian programs overseas	Western Wheat Associates; Catholic Relief Services; CARE; Lutheran World Federation; Seventh-Day Adventist Welfare Service; and Church World Service
Ethanolamine setting of permanent creases for military garments	Department of Defense (Quartermaster Corps for the Armed Forces)
Improved textures of frozen vegetables	National Association of Frozen Food Packers

IV PROGRAM MODIFICATION TO MEET CHANGING NEEDS

Planning and Advisory Activities

The U. S. Department of Agriculture program to find new and better ways to utilize farm products is based on extensive planning, continuous reviewing of results, and modification of these many efforts to reflect current objectives. These program activities take advantage of the findings and cooperation of many organizations and individuals both within and outside the Department of Agriculture.

The Deputy Administrator, administrative staff, and division directors of Nutrition, Consumer and Industrial Use Research are responsible for policy and planning. The Product and Process Evaluation Staff, composed of professional specialists, assists this administrative group in evaluating the commercial feasibility and general appropriateness of proposed and existing utilization research projects. In addition to the many contacts both within and outside the Department, special consultants, who are authorities in particular fields, assist in evaluating research and development activities.

Committee on Agricultural Science. An advisory group (16 members) of nationally recognized professional personnel, including representatives of State universities and experiment stations -- representing such disciplines as genetics, micro-biology, ecology, nutrition, physics, entomology, engineering, biochemistry, physiology, rural sociology, marketing, and economics -- that reviews, evaluates, and makes recommendations concerning USDA research in related basic sciences.

USDA National Agricultural Research Advisory Committee. An advisory committee (11 members -- six of whom shall be representatives of producers or their organizations) with broad national interests in all phases of agriculture, that evaluates the Department's entire research program and offers suggestions, particularly on policy matters, for modifications, additions, and deletions in the USDA program.

Agricultural Research Planning Committee. A 15-member advisory committee (composed of USDA director of Science and Education; six representatives from research agencies of USDA; six representatives of or nominated by State universities and land-grant colleges; one member nominated by the National Academy of Sciences; and one member nominated by the Office of Science and Technology) to assist in planning, evaluating, and coordinating unified long-range agricultural research programs and delineating the appropriate areas of responsibility of Federal and State agencies carrying out these programs.

National Advisory Committee on Rural Areas Development. An advisory committee representing agricultural industries, farmers, educational institutions, finance groups and regional representatives that makes recommendations for the greater development of rural areas.

Commodity and Functional Advisory Committees. The 13 Commodity and Functional Advisory Committees -- authorized under the Research and Marketing Act of 1946 -- offer suggestions on present work, make recommendations on needed future direction of research, and assure more effective communication with the many organizations interested in agricultural research:

- Agricultural Economics Research
- Animal and Animal Products Research
- Cotton Research
- Farm Resources and Facilities Research
- Forestry Research
- Grain and Forage Crops Research
- Horticultural Crops Research
- Human Nutrition and Consumer Use Research
- Marketing Research
- Oilseed, Peanut and Sugar Crops Research
- Plant Science and Entomology Research
- Tobacco Research
- Utilization Research and Development

State Agricultural Experiment Stations. The Directors and designated technical collaborators of the State Agricultural Experiment Stations, in the respective four national regions, that assist in planning research activities of mutual interest to the Federal and State groups.

Agricultural Associations and Industry Groups. Advice is sought, and technical and related information exchanged, from all segments of the agricultural industry -- growers, shippers, processors, and distributors -- concerning the many problems of profitably converting agricultural commodities to newer and broader uses.

Consumer Interest. Consumer desires for new and improved products, as well as evaluation of newly developed items, are sought through contacts with consumer groups of national and regional scope. Other USDA groups give assistance in consumer needs and market trends -- Economic Research Service, Federal Extension Service, and market and consumer use research groups in ARS.

Program Dynamics

The Utilization Research and Development program is continuously appraised and reviewed (1) to determine fruitfulness of the research efforts, (2) to discontinue investigations that have reached the point of optimum return or appear unrewarding of useful results, and (3) to direct new or to intensify existing research efforts to meet new needs either by reduction of effort on projects of lesser importance or by new resources that may be available.

Typical examples of redirected research efforts are given in the following chart:

Research Terminated or Redirected	Research Initiated or Expanded (Made possible by the research terminated or redirected)
<u>Cereals and Forage Crops</u>	
Processes for water-dispersible protein preparations from wheat	Pilot plant evaluation of methods of producing protein-rich, milk-like beverages from wheat
Exploratory studies to convert wheat flour into water-resistant, plastic-like products	Synthesis and characterization of crosslinked starch derivatives for use as paper additives
Chemical reactions of dialdehyde starch in solutions for industrial applications	Evaluation of acid-modified wheat flour and cyanoethylated starches as surface sizing agents in paper
<u>Cotton, Wool, and Other Fibers</u>	
Development of test methods for stretch cotton textiles for use as a guide in producing better cotton stretch yarns and fabrics	Investigation of wet and dry tensile recovery mechanisms of stretch cotton fabrics
Investigations of finishing treatments to produce wash-wear cotton stretch fabrics with improved strength, drape and hand	Investigation of slack mercerization followed by partial stretching to produce abrasion resistant wash-wear fabrics
Modifying wool, both by radiation grafting of polymers to the wool and by direct chemical modification, to improve its drying properties	Development of practical means for reducing drying time for wool fabrics

Research Terminated or Redirected	Research Initiated or Expanded (Made possible by the research terminated or redirected)
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Fruits and Vegetables

Explosion-puffed drying of fruits and vegetables by external heating means	Improved explosion-puffed drying by injection of super-heated steam
Identities, quantities and chemistry of components in Florida grapefruit responsible for excessive bitterness and harshness in processed products	Expanded development of grapefruit products with greater attractiveness by preventing or minimizing the formation of bitter substances
Development of an improved system for making apple juice of higher yields and containing less insoluble material	Application of new apple juice techniques to similar studies for improving juice recovery from grapes

Oilseeds

Basic investigations on improving the flavor stability of soybean oil	Exploratory studies on development of new hydrogenation catalysts for converting the unstable component (linolenic acid) of soybean oil to flavor-stable products
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New and Special Plants

Decreased emphasis on possible new crops of lower potential, such as for gums and pulping fibers	Increased emphasis on developing processing and uses for Crambe as a new crop
Hypochlorite modification of rosin	Expanded development of practical methods for preparing and industrially evaluating the levopimaric-formaldehyde adduct

Poultry, Dairy, and Animal Products

Studies of cold-tolerant bacteria in poultry meat products	Expanded study of controlling <u>Salmonella</u> in egg products through pasteurization
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Utilization Research Projects Terminated in F. Y. 1965

A total of 95 domestic research projects were terminated in F. Y. 1965 for the following reasons:

Research objectives attained	54
Research objectives partially attained	24
Research results unpromising or superseded by research of higher priority.	<u>17</u>
Total terminated	95

In F. Y. 1965, 25 foreign research projects (under P. L. 480) were completed -- India (1); Israel (1); Finland (3); France (3); Italy (4); Spain (5); United Kingdom (8).

Utilization Research Projects Initiated or Revised in F. Y. 1965

One hundred seventy-nine utilization research projects were initiated or revised in F. Y. 1965 -- 138 domestic and 41 foreign projects.

COMMODITY	INDUSTRIAL USES		FOOD USES		FEED USES		TOTAL	
	<u>1/</u> Dom.	<u>2/</u> For.	Dom.	For.	Dom.	For.	Dom.	For.
Cereal grains and forages . .	19	7	8	1	5	--	32	8
Cotton and wool	25	11	--	--	--	--	25	11
Fruits and vegetables	--	--	21	3	--	--	21	3
Oilseeds.	7	5	9	3	4	1	20	9
New and special crops	14	1	3	--	2	--	19	1
Poultry, dairy and animal products.	10	5	11	4	--	--	21	9
Total initiated or revised	75	29	52	11	11	1	138	41

1/ Domestic

2/ Foreign

Summary of Utilization Research Projects for F. Y. 1965

Type	Active at Beginning F. Y. 1965	Initiated or Revised	Terminated	Active at end F. Y. 1965
Domestic	419	138	95	462*
Foreign	152	41	25	168
Total	571	179	120	630

*Includes 20 projects directly supported by industry (fellowships and direct finance support), 196 domestic contract and grant projects, and 5 projects supported by funds transferred from other Federal agencies.

New Research Initiated with Increased Appropriations

Cereals and Forage Crops

In-house: Studies initiated on a comprehensive survey of mold metabolite content in corn, wheat, grain sorghum, and oat samples taken from trade channels.

In-house: Studies on the industrial use of cereal products augmented by funds made available for purchasing nuclear magnetic resonance equipment and installation of equipment for evaluating the use of starch and flour products in paper.

University grant: Basic studies initiated on the mechanical properties of the corn kernel to obtain needed information for improvement of dry milling.

University grant: Basic engineering research initiated on unit processes for the modification of cereal starches and flours.

Contract: Studies initiated on starch derivatives for use in water-emulsion paints.

University grants (2): (1) Study of methods for the separation of enzymes, and (2) investigation of bacteria as a source of enzymes for the modification of starch for industrial use.

University grant: Research initiated on glycoproteins from cereal grains.

Contract: Development of methods -- chemical or physical -- to process alfalfa so that the fiber content will be more digestible by livestock.

Cotton, Wool, and Other Fibers

Contract: Studies increased on the best use of high energy radiation in modifying finishing treatments of wools to improve their properties.

Contract: Development of wash-wear cotton fabric with improved moisture absorptivity by use of reactive swelling agents.

Contract: Development of finishes for cotton fabrics to render them more rapid drying.

Grant: Elucidation of the role of fiber morphology on frictional behavior important in mechanical processing of cotton fibers and in the behaviors of cotton products.

Contract: Development of a research instrument for accurately and automatically determining length, length distribution, and diameter of cotton fibers.

Fruits and Vegetables

Contract: Development of a practical assay method for measuring the bitter components of navel orange juice.

Contract: Study of the undesirable precipitates which form during the production of wine, and to develop improved techniques for removing them.

Grant: Studies on the enzymes involved in lipid synthesis and degradation in vegetable products.

In-house: Investigations of the carotenoid pigments in fruits and vegetables to facilitate the development of improved and more attractive processed products.

In-house: Development of processed grapefruit products of greater attractiveness by preventing or minimizing the formation of bitter components.

In-house: Study of off-flavor development in processed citrus juice in relation to lipid composition of the suspended matter.

Oilseeds

In-house: Expansion of research on the isolation, identification, evaluation and control of fungi and toxic fungal metabolites which may develop during processing of cottonseed and peanuts to improve the acceptance of their processed products.

Grant: Development of procedures for synthesizing labeled malvalic acid esters.

Contract: Study of sterilizing or inactivating treatments in conjunction with drying and curing of peanuts to develop processing conditions needed for producing mycotoxin-free roasted peanut products of optimum quality.

In-house: Development of an economically feasible method for the inactivation or removal of aflatoxins from contaminated cottonseed, peanuts, and their products to permit utilization in foods and feeds.

In-house: Research expanded on water emulsions of oilseed oil for paint and concrete coatings.

In-house: Development of new polymers from soybean oil for use in protective coatings.

Contract: Developmental studies initiated on pilot production of aldehyde oil products from soybean oil.

In-house: Development of high-quality full-fat soy flours for use in developing countries.

Contract: Study initiated of the natural antioxidants present in different varieties of safflower to provide a basis for improving the stability of this oil.

Contract: Polymerization studies initiated to investigate the usefulness of a number of monomers derived from such vegetable oils as castor, safflower, and cottonseed.

New and Special Plants

In-house: Development and evaluation of modifiers to be added to cigarettes for the purpose of altering the composition of the smoke.

Contract: Chemical identification and biological assay of the various components of tobacco smoke, particularly those producing biological activity.

Contract: Study of tobacco additives capable of modifying the burning temperature of cigarettes.

In-house: Investigations of the chemical characteristics of new sweet sorghum canes which determine their suitability for sugar recovery.

Poultry, Dairy, and Animal Products

Contract: Studies of selected chemical, physical, and enzymic means of altering the functional properties of egg white to provide a basis for developing new egg white products.

Contract: Development of a transportable system for the removal of radioactive strontium, iodine and cesium from milk.

Contract: Studies on the relationship between the feed of cows and the flavor stability of the milk.

Contract: Development of methods for the preparation of highly purified fats whose fatty acid composition and glyceride structure are precisely defined.

Contract: Methods for isolating, identifying and characterizing the non-carbonyl volatile compounds in rancid meat fat.

V CURRENT UTILIZATION RESEARCH PROGRAM

The USDA utilization research and development program is a coordinated effort of basic and applied research to give optimum returns in the shortest practical time. At present, these efforts are devoted to the following areas:

Cereal Grains and Forages. Emphasis on development of new uses for corn and wheat, with continuing investigations on rice, barley, oats, sorghum, and alfalfa and other legume and grass forages:

New and improved food products -- new puffed bulgur products; textural improvements in the emergency wheat wafer; milk-like products from wheat for use in developing countries; new foods made possible by "deep-milling" of rices; fermented wheat foods (tempeh).

Basic research on cereal grains -- wheat protein interactions, particularly the cohesive properties of gluten; wheat enzyme activities; effects of lipo-protein complexes on dough properties; bread flavor formation elucidated by model systems; factors involved in producing spores of bacterial pathogens, useful for controlling Japanese beetle, when grown on grain-based media.

New Safeguards for cereal grain products -- processes for removal of radioactive contaminants from wheat and wheat flours; methods for reducing micro-organisms in flours; survey of possible aflatoxin infestations in rice, wheat, sorghum, corn, and oats in trade channels.

Improved feeds -- biological activity of minor alfalfa components affecting growth responses; methods for making alfalfa fiber fraction more digestible by livestock; improved dehydrated coastal bermuda grass and pearl millet products; possible relation of mycotoxins in forages to fescue foot disease; new high-yielding strains of beta-carotene-producing microorganisms; processing effects upon carotenoids in corn.

Industrial uses -- processes for crosslinking of pulp-starch-zanthate in paper products; development of better pine plywood bonding materials from soyflour-blood-dialdehyde starch; new industrial products through graft polymers of starches and flours; improved starch derivatives for use in water-emulsion paints; improved corn dry milling procedures.

Cotton and Wool. New functional properties imparted to cotton and wool through chemical, physical, and mechanical processing research and development, supported by comprehensive fundamental studies of fiber properties and modification:

Cotton chemical processing -- processes to improve wrinkle, chlorine, and abrasion resistance of wash-wear cottons; multi-functional, single-application treatments to give all desired wash-wear properties including improved luster; better stretch cottons with wash-wear characteristics; processes to improve moisture absorptivity and drying rates of wash-wear

fabrics; weather- and flame-resistant treatments for cotton; further improved cotton battings; cellulose swelling related to abrasion resistance of cottons, radiation-induced graft reactions of cotton; cellulose etherification mechanisms.

Cotton mechanical processing -- better methods of feeding the cotton card; devices for removal of short fibers from lint cotton; aerodynamic methods for individualizing cotton fibers; frictional behavior important in mechanical processing of cotton fibers.

Easy-care wool finishes -- continued research on the WURLAN processes for wool fabrics and knitted goods to reduce treatment costs, to develop more compact and efficient treating equipment, and to define trade-wide standards.

Other ways to improve wool -- processes that provide oil-, water-, and stain-repellency for wool; lubricants to facilitate high-speed processing of wool; polymeric treatments for multiple-purpose finishing of wool; various effects of irradiation on wool fibers.

Fruits and Vegetables. Development of convenience-in-use fruit and vegetable products, and processing equipment for their economic manufacture, augmented by fundamental investigations on factors affecting color, texture, and flavor:

Citrus and sub-tropical fruits -- new food products from desert grapefruit; new de-bittered citrus juices and blends, including assay methods for measuring bitterness; improved storage and quality of foam-mat-dried citrus powders; new dehydrated banana products; new uses for guava, papaya, and passion fruits.

Deciduous fruits and berries -- new foam-mat-dried berry purees and cranberry juice; modified drum-dried apple sauce and apricot products; osmotic concentration of grape and other juices without application of heat; improved apple juicing system; methods for controlling microorganisms in cider; explosion-puff-drying of apples and other fruits; factors affecting flavor of cherry products; flavor and aroma studies to improve peach products.

Vegetables and potatoes -- elucidation of spore heat resistance affecting vegetable preservation; quick-cooking whole and powdered lima bean products; factors affecting quality of processed asparagus; new enzyme control methods and vacuum drying technique for tomato products; removal of radioactive fallout from vegetables; studies of enzymes affecting lipid reactivity in vegetable products; further improved explosion-puffed carrots, potatoes and other vegetables; factors affecting quality of frozen French-fried potatoes; enzymes and antioxidants to improve sweetpotato flakes.

Oilseeds. Principal research on soybean, cottonseed, and linseed oils, meals, and related products, with additional investigations on castor, safflower, and selected oilseeds resulting from the new crops screening program:

Industrial uses -- development of practical solvent systems for ozonization of vegetable oils, methods for increasing oxidative stability of cyclic acid derivatives; preparation and characterization of derivatives of oilseed monomers; linseed oil for emulsion paints and protective treatments for concrete; new protective coatings from soybean oil; studies of safflower oil constituents leading to specific industrial uses.

Food uses -- continued studies of selective hydrogenation, particularly for soybean oil; full-fat soy flours for use in developing countries; methods for detecting and controlling toxic metabolites of mold contaminants in oilseed products; relation of selected constituents of peanuts to the formation of flavor and aroma during roasting; new peanut food products such as low-calorie peanuts, chips, flakes, milk-type drinks, baking flour, and confectionery goods; processes for making peanut flours and cottonseed flours for use in developing countries; removal of off-flavor and off-color from safflower oil; new stabilizers for cottonseed oil emulsions.

Feed uses -- basic information on soybean meal proteins; inactivation of cyclopropanes and control of gossypol in cottonseed meal products.

New and Special Plants. Investigations directed to develop compositional data on plants from world-wide sources in an effort to find alternate crops to fill needs not now met by domestic sources, and to develop new and more economic uses for domestic special plants:

Naval stores products -- new industrial chemicals from pine gum, turpentine, and rosin.

Tobacco -- broadened program to emphasize studies of biologically-active compounds in tobacco leaf and smoke, determination of products formed on burning leaf tobacco, effect of added chemicals on smoke composition, and development of rapid bioassay methods and measurement of tobacco smoke condensates by these methods.

New alternate crops -- industrialization of new oilseeds, particularly the processing of erucic acid oils, and the development of chemical derivatives from these sources; processes to improve flavor and nutrient properties of Crambe meal for feed purposes; industrial uses for Crambe oil and derivatives.

Other crops -- improved techniques for manufacturing maple and sorghum sirups.

Culture collection -- enhancement of the ARS 15-thousand microorganism collection used for commercial manufacture of antibiotics and other pharmaceuticals, insecticides, and industrial products.

Poultry, Dairy and Animal Products. Development of better and more economic food products from poultry, eggs, milk and meat, and development of new industrial outlets for fats, hides, and other animal, dairy and poultry byproducts:

Poultry products -- structural changes in poultry meat induced by combinations of freeze-thaw-heat cycles; new processes for continuous freeze-drying of raw and cooked chicken meat and other products.

Egg products -- effect of pasteurizing techniques upon egg components and contaminants such as Salmonella; factors contributing to Salmonella contamination in egg products; improved density and rehydration properties of dried egg products; chemical, physical, and enzymic means of altering functional properties of egg white leading to new products.

Dairy products -- constituents responsible for stale flavor in milks; mechanisms for antigelling properties of milk concentrates; improved vacuum-foam-dried whole milks; further improved processes for cheese-making, particularly for increasing flavor intensity; development of a transportable system for removal of radioactive strontium, iodine and cesium from milks.

Meat products -- new formulations and methods of preparing comminuted meat and smoked meat products; time-temperature tolerance studies of frozen meat products; methods for modifying flavor and aroma constituents of meat products; curing organisms to produce desirable flavor in rapidly cured pork products.

Byproducts -- new lubricants and biodegradable detergents from chemically-modified fats; further uses for glutaraldehyde tanning for leathers; re-generated collagen products from hide materials.

VI FINANCIAL INFORMATION

The F. Y. 1965 and F. Y. 1966 domestic utilization research and development funds under "Salaries and Expenses, Agricultural Research Service," including allotments from the Special Fund for additional labor, are as follows:

	<u>F. Y. 1965</u> (Obligations)	Proposed Distribution <u>F. Y. 1966</u> (Estimated)
Cereal and forage crops.	\$ 6,632,204	\$ 6,590,400
Cotton, wool and other fibers. . . .	5,721,643	5,855,300
Fruits and vegetables.	4,338,709	4,360,600
Oilseeds	3,901,988	3,758,300
New and special plants	3,164,175	2,639,200
Poultry, dairy, and animal products.	<u>6,126,038</u>	<u>6,348,800</u>
Total	<u>\$29,884,757</u> ^{a/}	<u>\$29,552,600</u> ^{b/}

^{a/} Includes \$3,958,711 obligated under funds transferred from Section 32. The 1965 obligation also includes funds appropriated under the Second Supplemental Appropriation Act, 1965 for increased pay costs pursuant to Public Law 88-426 and wage board increases.

^{b/} Excludes amounts needed to meet pay costs pursuant to Public Law 89-301 and wage board increases. Includes \$4,150,000 from Section 32 which were merged with Salaries and Expenses.

In addition to the above funds, there were obligations of \$10,168 under a non-recurring allocation from the Contingency Research Fund for purchase of scientific equipment to intensify planned in-house research in Kentucky on health-related problems of tobacco, and \$1,200 obligated under funds appropriated in the Second Supplemental Appropriation Act, 1965 for research in the Appalachian Region.

The 1964 Appropriation Act authorized use of the following funds for construction as follows:

1. Transfer of CCC funds:

Construction of utilization research and development facilities --
\$9,750,000:

California, Albany	\$ 1,500,000
Florida, Olustee	250,000

Illinois, Peoria	\$ 4,500,000
Louisiana, New Orleans	1,500,000
Pennsylvania, Wyndmoor	1,500,000
Texas, Weslaco	250,000
Survey, determination of need, and planning of additional research facilities as may be required for utilization research in the Southeast and weed control research, not to exceed.	<u>250,000</u>
Total UR&D Construction	<u>\$ 9,750,000</u>

2. Section 32 fund transfers authorized for:

Georgia, Athens - Construction of Southeast utilization research and development laboratory.	\$ 9,500,000
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The above facilities are in various stages of design and construction.

As indicated above, the total obligations in F. Y. 1965 for domestic utilization research and development, exclusive of construction, were \$29,896,125.

In addition to the domestic program, the equivalent of approximately \$2.72 million in foreign currencies was obligated in F. Y. 1965 for utilization research projects (largely extending over a five-year period) conducted under agreements with foreign institutions. This work is financed by funds generated under the P. L. 480 program.

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The 1966 Appropriation Act provided for continuation of projects initiated in Fiscal Year 1965 with Section 32 funds and for redirection of some of these funds from other projects for additional research on livestock products, as follows:

1. Projects continued:

Research on mold problem (mycotoxins, including aflatoxins) of peanuts, other oilseeds and cereals	\$ 350,000
Research to identify health-related constituents of tobacco.	200,000
Development of new and improved industrial products from cereals	650,000
Development of new and improved cotton textiles, research on cycloprene acids in cottonseed. . . .	500,000
Development of new dehydrated and frozen milk, meat, poultry and egg products, new and improved industrial uses for animal fats and hides, wool and mohair.	500,000
Development of new and improved industrial products from soybeans, flaxseed, peanuts, castor and safflower.	300,000
Research on horticultural crops, including citrus, grapes, and other fruit and vegetable products.	500,000
Research on processing of sugar sorghum and forage crops.	100,000
Research in Kentucky on health-related problems of tobacco.	<u>900,000</u>
Sub-total.	\$4,000,000

2. Additional research:

Transfer of 1965 non-recurring funds from food consumption survey for studies on utilization of livestock products	<u>\$ 150,000</u>
Total utilization research and development provided under transfer of Section 32 funds to Salaries & Expenses F. Y. 1966	<u><u>\$4,150,000</u></u>

The F. Y. 1966 Appropriation Act also provides for the following changes:

<u>Project</u>	<u>Program Increases (\$)</u>	<u>Decreases (\$)</u>	<u>Estimated non- recurring increase to close out pro- jects in Decreases' column (\$)</u>	<u>Total (\$)</u>
Cereal and forage crops:				
Research on toxin- producing molds and their control	+50,000	--	--	+50,000
Fruits and vegetables:				
Elimination of research at Prosser, Washington. .	--	-48,900	+ 8,700	-40,200
Research on toxin- producing molds and their control	+15,000	--	--	+15,000
Oilseeds:				
Elimination of research on tung	--	-93,400	+ 5,000	-88,400
Reduction of research on castor beans.	--	-164,600	--	-164,600
Research on toxin- producing molds and their control	+105,000	--	--	+105,000
New and Special plants:				
Reduction of research on sugars and sirups. . .	--	-613,800	+34,800	-579,000
Reduction of research on new and replacement crops	--	-330,800	+25,100	-305,700
Research on health- related problems of tobacco	+237,000	--	--	+237,000
Total change	<u>+\$407,000</u>	<u>\$-1,251,000</u>	<u>\$+73,600</u>	<u>\$-770,900</u>

VII SELECTED RESEARCH ACCOMPLISHMENTS

WORLD Wheat attracts interest both in the United States and in Asia. Cooked whole-kernel wheat, free of colored bran -- called WORLD Wheat -- has been substantially improved during this past year by its Department inventors. Industry had raised certain objections to the earlier WORLD Wheat process: high water consumption, unsaleable bran byproducts, and difficult effluent disposal. All these objections have now been overcome. Better lye treatment has (a) reduced water use to 8 pounds per pound of wheat, (b) produced a compressible bran which can be used in feeds, and (c) resulted in an effluent capable of biological reduction to a harmless state. These improvements also have markedly reduced the cost of the process. A continuous and automatic pilot plant -- utilizing the new improved procedures -- has been built to determine the best conditions for future installations. The plant, rated at 250 pounds per hour, has been used to make several tons of WORLD Wheat which was tested in Hong Kong by Church World Services. Acceptability of the product was found to be outstanding. The new process is competitive in costs with conventional bulgur processing.

Polysaccharide gum from corn sugar commercialized. Four industrial companies are now producing "B-1459" water-soluble gum by the Department's process for bacterial fermentation of corn sugar. This gum has a potential multimillion-pound market in industrial and food uses. Solutions of the gum in water exhibit unusually high viscosities that are stable over wide ranges of temperature and concentrations of salts, acids, and alkalies. In contrast, presently available commercial gums are deficient in one or more of these qualities. Two of the companies have submitted requests for Food and Drug Administration approval, based largely on Department feeding tests showing negative toxicity.

Improved Wheat flours. Department scientists have developed methods for treating wheats, as well as flours milled from them, to reduce the microbial population in the finished flours to very low levels -- 1 percent or less of the number present when the treatments are not used. Since the microorganism content of flours is important to the storage life of refrigerated, frozen, and cooked convenience foods, most manufacturers of convenience foods are purchasing flour under specifications designating maximum permissible levels of bacteria, molds, and yeasts. Without special treatments, flours are normally too high in microbial count for use in the convenience foods. Studies have shown that finished flours can be improved substantially by grain cleaning and the use of certain chemical agents in the washing and tempering waters. However, when the level of microorganisms is high in the wheat, such treatments do not give a low enough count in the flour for critical uses. This difficulty has been overcome by developing processes based on moderate heat treatment of the wheat before milling or of the flour after milling. Processes involving these heat treatments could be adapted to any mill with only moderate additional capital expenditures and operating costs.

Standby process for reducing radioactivity in wheat. The Department has demonstrated a feasible method for the reduction of the radionuclide, strontium-90, in wheat and its milled products. Radioactive fallout is primarily deposited by rains, substantially in water-soluble form, and deposits on the foliage and seed head of the plant and in the soil. Under present low levels of atmospheric radioactivity, about 80 to 90 percent of the strontium-90 in wheat grain results from surface deposition of fallout and 10 to 20 percent from absorption through the roots. In case of high density fallout, however, a much higher proportion of the total radioactivity would be surface deposition. A washing procedure using warm dilute solutions of phosphoric or citric acids (well-known food acids) has been developed by Department scientists which can be integrated into the milling process. Using this process, a total of about 75 percent of the strontium-90 was removed from a hard winter wheat blend; the milled fractions showed decreased radioactivity of 81 percent for the bran, 71 percent for shorts, 45 percent for clear, and 27 percent for patent flour. These results indicate that wheats can be decontaminated sufficiently for food purposes in times of emergency. Also, the treatment offers the possibility of providing feed fractions that are considerably improved with respect to strontium-90 content.

High protein rice flours. Department scientists have shown that substantial quantities of rice flours of up to 16 to 20 percent protein can be abraded from the surfaces of either ordinary or parboiled milled rices. Currently available types of milling machinery are used, thus production cost is minimal. When only three to five percent of the starting rice is milled off, the residual kernels are whiter, cook better, and have negligible breakage. The color improvement is especially prominent with parboiled rice. The rice thus has a slightly higher sales value, perhaps high enough to offset the cost of producing flour. The bland flours are non-allergenic, low in fiber, and provide high quality protein for infants, for adults with high blood pressure, and for elderly people who have dietary problems with normal sources of food protein. A large potential export outlet for the flour also exists to supply protein for weanling children in developing countries. The cooked flours from parboiled rice can be used directly to make gruels, or they can be converted to powdered soluble beverages in this country for sale overseas. Further studies are being undertaken in cooperation with UNICEF and with industry to incorporate these flours into new products such as baby foods, beverages, and soups.

New dehydrated alfalfa data for least-cost feed formulations. A cooperative basic research effort has been undertaken by the Department, two universities, a major feed company, a research institute, and the American Dehydrators Association to acquire precise analytical data for all nutrients in dehydrated alfalfa and other processed feedstuffs as a prerequisite to calculating least-cost feed formulations. Such complex calculations previously have been impossible due to inadequate analytical methods for alfalfa products and to lack of high-speed electronic computers. Dehydrated alfalfa samples from all major production areas of the country have been subjected to exhaustive chemical analyses and metabolizable energy assays utilizing newest-developed techniques.

Thus, an important gap in basic knowledge is being filled and this knowledge is being used by industry to make effective use of alfalfa meals in minimum cost feeds. The research is now being extended to other forage crops.

High-fashion stretch cotton lace prepared by simple process. A simple, inexpensive process has been developed by Department scientists for the production of stretch cotton lace with attractive esthetic properties, including a sculptured three-dimensional texture prized in the fashion world. The process -- an adaption of the slack mercerization process now used extensively in the production of all-cotton stretch fabrics -- is applied to conventional machine-made laces to give these normally flat laces a rich, full, and more expensive appearance. Amount and direction of stretch can, by design and weave, be confined to specific segments of the lace pattern to make them stand out in relief. The new properties are durable and can be enhanced further by a resin treatment to impart dimensional stability and wash-wear properties to the lace. Interest has been expressed by several lace manufacturers, and lace products of this type should be in commercial production in the near future.

Commercialization of improved cotton batting assured. Widespread commercialization is assured of "Cotton Flote" -- the new chemically treated cotton batting developed in cooperation with the National Cotton Batting Institute, Textile Waste Association, National Cottonseed Products Association, and the Foundation for Cotton Research and Education. One major automobile manufacturer approved the new batting for use in some of its 1965 models; and one producer of batting has already manufactured and supplied large quantities of Cotton Flote for this purpose. It is anticipated that two other major automobile manufacturers will approve the product soon. At least seven other batting producers are piloting the process for making Cotton Flote. Because of its improved resilience, dimensional stability, and coherence, Cotton Flote is competitive with all types of cushioning materials, including polyurethanes and foam rubber. As the availability of the new product increases, its use will undoubtedly be extended to the bedding and furniture manufacturing industries. The use of cotton fibers by the automotive, furniture, and bedding industries represents potential cushioning markets exceeding \$1 billion at the retail level.

New antimicrobial agents for cotton fabrics commercialized. In cooperation with the Canvas Products Association International and the Foundation for Cotton Research and Education (affiliated with the National Cotton Council of America), Department scientists recently developed an efficient, inexpensive treatment (based on new zirconium-copper agents) for improving cotton fabric resistance to weather and rot. The new agents, all the components of which are commercially available, have the advantages of good resistance to microorganisms such as mildew and algae, good durability, low cost, freedom from odor, and ease of application. Cotton treatment has completely resisted mildew and algae growth for more than 36 months of outdoor exposure. Five companies are currently using the new treatment for commercial production of outdoor weatherable cotton fabrics, and at least 25 other companies have expressed interest in the discovery. The major potential for these new antimicrobial agents is for tarpaulins, shoe linings, boat covers, industrial thread,

awnings, and tobacco shade cloth. The market potential is estimated to be equivalent to 265,000 bales of cotton per year.

Superior wash-wear finishes adopted by industry. Carbamate wash-wear finishing agents, developed by Department research scientists, are being produced commercially in the U. S. and abroad. These agents are currently used to treat an estimated one million yards of cotton fabric per day. The carbamates produce high-quality wash-wear finishes with outstanding durability to damage by laundering and chlorine bleaching. In addition to retention of smart appearance, the superior durability prevents garment shrinkage after a few launderings as sometimes occurs with cottons treated with less resistant finishes. One of the new carbamates shows promise for quick commercialization. In addition, this carbamate appears to be a good agent for deferred cure finishing to produce durably creased, wash-wear cotton garments. Representatives of three large industrial manufacturers have stated that the cost of carbamate intermediates used in preparation of these wash-wear finishes can be reduced to make the new agents competitive with all but the cheapest wash-wear agents.

Formaldehyde stops yellowing of moist wool. A new formaldehyde treatment protects raw wool from the yellowing and consequent economic losses which occur when fleece is shorn and baled under adverse conditions. If the moisture content of the raw wool is over 30 percent, the temperature within the bales rises as much as 40° F. within a week. Yellowing starts at once and increases for many weeks. Both the yellowing and the temperature rise are associated with a combined chemical and microbial action. It has now been discovered that both chemical and microbial action can be prevented by spraying the raw wool with a dilute formaldehyde solution or by lightly dusting with paraformaldehyde prior to baling. Cost of the additional processing is negligible -- in the order of 0.2¢ per pound of grease wool. This new treatment will save money by (a) eliminating a bleaching step in processing, (b) avoiding the consequent fiber weakening, and (c) maintaining the higher price which white wool commands. Avoidance of bleaching is also desirable because, while it may temporarily whiten the wool, the yellow color often reappears during later use, especially if the wool is washed in hot water.

New and improved peach products. A number of attractive processed peach products developed by the Georgia Agricultural Experiment Station, under contract research through funds supplied by the Area Development Administration, are being successfully evaluated. A major advantage of several of the new products is that they provide markets for surplus peaches and for peaches whose size and appearance make them unsuitable for use as fresh fruit. Clear peach juice concentrate has already been commercialized for use in wine stock and is a potential ingredient of peach jelly, marmalade, waffle sirup, ice-cream, and fruit drinks. Puree-type peach concentrate, based on the contract research and made by a commercial food processor for test marketing by the Georgia Peach Commission, has evoked favorable evaluation. Chilled peach sections also have been successfully test marketed and appear to be a particularly promising product. Representatives of industry are presently exploring the feasibility of building a new plant to manufacture the new peach products. Other products are in various stages of development.

In research carried out by the New Jersey Agricultural Experiment Station under a USDA contract, several new freestone and clingstone peach varieties with excellent processing characteristics have been discovered. A total of 46 freestone and 61 clingstone varieties were tested during three successive seasons (1962-1964) for suitability for canning and freezing. One freestone variety, which was highest in vitamin A and C contents and outstanding in flavor, particularly is expected to play an important role in future breeding programs.

Bitter limonin discovered in grapefruit juice. Excessive bitterness is one of the main factors that limits the consumer acceptability of grapefruit juice. In the past, grapefruit bitterness was ascribed to a substance called naringin, whereas the bitterness of navel orange juice is due to another compound, limonin. Department scientists have now discovered that limonin also may occur in grapefruit juice in amounts (up to 10 parts per million) sufficient to contribute significantly to the bitterness of the juice. Limonin, when present, is located primarily in the pulp of the fruit and enters the juice during extraction. The knowledge that limonin, as well as naringin, contributes significantly to the bitterness of grapefruit provides for the first time a sound basis for developing a successful debittering process.

New onion pungency test adopted by industry. Onions, with a farm value of \$85 million, are the sixth largest vegetable crop grown in the U. S. Because onions are used in foods largely for their appealing pungency, the value of dehydrated onions is directly related to their strength of flavor. Basic research by Department scientists has now led to a new objective method for measuring flavor strength of onions. They (a) discovered the principal chemical reaction responsible for flavor development when onion cells are crushed, (b) showed that the quantity of pyruvic acid produced by this reaction is directly related to pungency, and (c) then developed a test to measure the pyruvic acid. This achievement has been adopted by the domestic dehydration industry for selecting raw materials for processing, and by plant breeders to obtain varieties of onions more suitable for processing. In addition, one large user of dehydrated onions specifies purchases according to this test. This Department research is thus resulting in improved products for U. S. consumers.

Progress made in aflatoxin research. Significant progress has been made toward controlling contamination of agricultural products with aflatoxin, potentially a problem for many agricultural commodities. An essential first step was the development of efficient methods of assay. Procedures devised for analysis are faster, more accurate, and more sensitive than those available only a year ago. In fact, a new micro method permits assay of even a small piece of the commodity under consideration. A working standard prepared by Department scientists and distributed widely to laboratories requesting it has greatly improved standardization of results. Animal feeding tests are being conducted to determine the relation of aflatoxin to adverse physiological effects and to assess the possibility of its transmission in food products. Several important methods of inactivation or removal of aflatoxin appear promising: (a) extraction with a mixed solvent such as acetone-hexane-water has proved effective; (b) chemical

treatments, particularly those based on ammonia, appear to be promising; (c) environmental conditions that limit growth of aflatoxins are being defined as a means of preventing or at least minimizing aflatoxin occurrence in commodities.

Low-calorie, protein-rich, whole peanuts. Low-fat peanuts can now be prepared by a new process without the use of solvents. Whole peanuts are mechanically pressed until most of the oil is removed; they are then expanded to their original size, dried, roasted, and salted. This new product contains about 65 percent less fat than conventionally roasted peanuts. With the removal of the oil, percentage of each of the remaining constituents is correspondingly increased. Thus, the percentage of proteins in the extracted product is much higher than in the original peanuts. These peanuts have the shape of conventionally preferred peanuts and closely simulate their texture, flavor, and aroma. Acceptance of these savory, low-calorie peanuts is expected to expand rapidly when the laboratory process is scaled up to commercial use. This development should strengthen the half-billion dollar retail market value of peanuts derived from the \$200 million farm value of the peanut crop.

New fire-retardant paints based on tung oil. Major progress has been made in the development of water-resistant, intumescent, fire-retardant coatings based on tung oil and its derivatives through cooperative research with the U. S. Army Engineer Research and Development Laboratories and the Pan American Tung Research and Development League. Although fire-retardant paints are available commercially, they are unsuitable for many domestic, industrial, and military uses, since they lack some requisite conventional properties (such as water resistance) and thus cannot be applied to exteriors. In Department research, vehicles containing tung oil or chemically-modified tung oil have been synthesized and formulated into paints. These experimental coatings are highly resistant to water and to weather; they perform well in the standard Underwriters Laboratories 25-foot tunnel furnace test, and also have good drying and bonding characteristics and serviceability. The tremendous industrial interest in those formulations indicates that commercialization would consume large volumes of domestic vegetable oils -- not only tung, which is an essential component, but also linseed oil, dehydrated castor oil, and others.

Improved stability of linseed oil emulsion paints. Department scientists have made another important contribution to expanding the use of linseed emulsion paints by discovering a novel way to give these products greater stability. Conventional linseed oil paints usually contain zinc oxide to prevent growth of mildew on the paint film. In water-based paint systems, the zinc oxide and titanium oxide (a white pigment used in most exterior paints) develop opposite electrical charges. This causes gradual clumping, and greatly shortens the storage life of the paint. Department scientists have found that addition of a commercially available phosphate chemical overcomes this problem and gives the paints the needed increase in storage life. Results of this research also make it possible to predict the occurrence of interactions between particles of other paint pigments that might be used, so that undesirable combinations can

be avoided. Based on this and other basic research, industrial production of linseed emulsion paints is making rapid gains. Three major producers are now marketing linseed emulsions for use in formulating paint. One of these alone is supplying emulsions to some 150 paint manufacturers. One of the nation's largest retailers is among those distributing linseed emulsion paints. The potential annual market exceeds 140 million pounds of linseed oil.

Low-cost, non-burning, rigid polyurethane foams from castor oil. The construction industry is a potential yearly outlet for as much as one billion pounds of plastics for insulation and vapor barriers. Polyurethane foams, with their unique property of on-site fabrication, should realize a large share of this market as they become accepted by the building industry. For making these polyurethane products, a reactive liquid mixture can be poured into voids (e.g., roof, floor, or wall members) where it foams up and fills the void with an instantly-formed rigid foam that gives strength and provides a stable barrier against heat, sound, and vapors. Such polyurethane foams are now mainly based on petrochemicals, but Department research has demonstrated that modified castor oil can be used to make polyurethane foams. These castor-oil-based foams can be made flame-resistant with no loss in other properties by incorporation of reactive flame-resistant chemicals. These completely non-burning foams are significantly less expensive than similar fire-resistant foams based on petrochemicals. Based on the results of this Department's research, several large fatty acid processors have initiated development programs in this field. Large increases in castor oil could result, requiring up to 200,000 new acres of castor.

Crambe oil for the steel industry. Oil from crambe, a new crop being developed by the Department, has been evaluated in cooperation with industry as a mold lubricant for the continuous casting of steel. The results showed that crambe oil is superior to any other material tested or used to date for this purpose. In continuous casting, molten steel is poured through an oscillating mold. Proper lubrication of the mold is essential to ensure continuous emergence of a high quality ingot. Continuous casting is a relatively new but rapidly growing process. Six years ago, there were less than 20 installations throughout the world. Today there are over 100. The potential market for crambe oil in this process is 7 to 8 million pounds annually. Substantially increased plantings of crambe are planned this year to provide oil for this outlet and to encourage development of still further end uses.

Kenaf, a new potential raw material for papermaking. Department scientists have demonstrated that kenaf pulp can be used to make a wide range of types of paper having commercially acceptable properties. Kenaf, which has been in the Department's program on new crops, is an annual crop that can be grown in many areas of the United States. Yields of over 10 tons per acre of dry matter have been readily obtained. Yields as low as 6 tons per acre should make the growing of kenaf economically feasible in lieu of corn and wheat according to studies by Department scientists. As a result of these studies, industrial interest in kenaf as a pulp crop is increasing. At least five major paper companies are investigating kenaf through plantings and pulping studies.

Commercial-scale process developed for removing strontium-90 from milk. Commercial-scale development of the fixed-bed method of removing radiostrontium from milk has been achieved successfully through contract research supported in part by the Public Health Service. The milk was processed at a rate of 12,500 pounds per hour in an established commercial dairy which had been equipped with strontium-90 removal equipment. More than 90 percent of the environmental radiostrontium was removed from the milk without appreciably affecting its appearance, flavor, wholesomeness, or nutritional quality. The additional equipment required can be readily integrated into commercial milk processing operations without significant increase in processing time. The additional cost for removing radiostrontium from milk is estimated to be from one to two cents per quart depending on the daily volume of milk being processed and the extent of reuse of removal materials. The method provides a feasible and practical "standby" means for commercially processing milk in the event of a high density fallout.

Composition and structure of animal fats elucidated. Department chemists have developed new, unique techniques for determining the composition and structure of animal fats in minute samples of the fat. The new method is highly specific and determines the nature of the fatty structure with absolute certainty. This type of basic information, which is leading to a better understanding of fat composition and structure, is essential to further expansion of animal fat utilization in improved shortenings and confectionery uses. In addition, because these techniques are particularly adaptable to very small samples, they are now finding wide application in the biomedical field for determining the glyceride composition of fats from tissue of small experimental animals, in studies of lipid metabolism as affected by certain diseases, and in plant genetics where it permits analysis of the fat in a single seed.

Perspiration-resistant leather expands markets. A new tanning process, developed by Department chemists, yields leather with increased resistance to deterioration by perspiration, chemicals, and washing. The process, based on tanning with glutaraldehyde, is already in use commercially by many tanners to produce improved shoe uppers, shoe insole, garment, and glove leathers from most types of hides or skins such as cow, horse, sheep, pig, kangaroo and reptile. The process imparts other desirable properties to leather by increasing its receptivity to dyes, oils, finishes, water-repellent treatments, and other post-tanning operations. These improved properties will place leather in a better competitive position with respect to leather substitutes, thus helping to maintain profitable outlets for animal hides. Industry estimates indicate that in 1964 over 40,000,000 square feet of leather were produced by the new tanning process. The largest volume use is for work shoes, where perspiration deterioration has always been a problem, with significant amounts being used for casual and dress shoes, and for work gloves.

New technique aids sausage manufacture. An analytical method has been devised by Department scientists for use in selecting meats to be manufactured into

emulsion-type products such as frankfurters and bologna. The new method measures the emulsifying capacity of meats, and is useful in predicting how meats will react in emulsion-curing which is the key operation in the manufacturing process. Combined with data on costs and other factors, the new numerical measurement provides indices which yield more accurate computations of the best and most economical formulas for emulsion-based products. Use of this technique results in a more nearly optimal use of meats, as well as precision and uniformity, in sausage making. Several meat packers, including at least two or three major manufacturers, are using this new technique in making sausage products.

Rapid method developed for determining Salmonella. The presence of Salmonella in food products and in raw materials can now be detected quickly and easily as a result of research under Department contract at Iowa State University. Other currently used assay methods for detecting Salmonella are both tedious and time consuming -- complete assays requiring from three to five days. A fluorescent antibody technique has been applied to the development of an assay method for Salmonella that can be completed in 10 to 24 hours. The new method compares favorably with existing methods both in reliability and sensitivity, and represents another step in the drive to eliminate Salmonella from food products.

Tobacco utilization research reoriented and expanded. Since publication of the Report to the Surgeon General on Smoking and Health, the emphasis in utilization research on tobacco has been shifted from studies on quality factors to investigations on smoking-health relationships. An extensive program has been initiated on the isolation and identification of new leaf and smoke components which may have physiological effects. Included in this program are studies on the neutral resins of leaf and heterocyclic bases of smoke which are being conducted under contracts at the Research Triangle Institute (Durham, North Carolina) and at the University of Kentucky, respectively. An investigation is underway on the development and evaluation of new cigarette additives capable of altering the smoke composition; the Houdry Process and Chemical Company, specialists in catalysis and process alteration, are under contract for a substantial part of this research. An extensive program has been initiated under contract at the University of Kentucky Medical School to provide a biological assaying service for the analysis of experimental tobacco and smoke condensates, and to conduct basic studies to develop more rapid biological assaying methods. This reoriented program will make significant contributions in elucidating the factors responsible for the physiological effects of tobacco smoke.

Superior cooking oil for World Market. Department scientists have developed new laboratory methods having promise for producing a flavor-stable soybean cooking oil and at the same time preserving its high nutritional value. Of further importance is achievement of the improved stability needed to withstand storage and transportation for foreign marketing. These improved methods are based on the discovery of new catalysts that show increased selectivity in promoting

hydrogenation of linolenate, the unstable component of soybean oil. It has been demonstrated that linolenate content can be reduced to adequately low levels without the need for winterization to remove excessively hardened oil. Studies are in progress on adaptation of these new methods for use by industry. Success should expedite the role of soybeans in supplying a large share of the annual world deficit of 4 billion pounds of food fats and oils.

Maple sirup improved. The use of paraformaldehyde pellets in maple tree tap-holes to prevent bacterial contamination and to improve the quality of the resulting maple sirup has stemmed from Department research. Furthermore, because the pellets prevent clogging of the tapholes, the sap crop can be materially increased without additional investment in capital or labor. This technique, developed cooperatively between Department scientists and the Michigan Agricultural Experiment Station, was put to a large-scale test for the first time during the 1962 maple season; by 1965 this practice had been generally adopted by the maple industry. The use of these pellets has substantially increased returns to maple producers by improvement of sirup quality and total production.

Bacterial Rennets for Cheesemaking. Indian scientists working under a P. L. 480 research grant have reported promising results toward production of bacterial enzymes as substitutes for calf rennet in cheesemaking where its use is restricted by religious beliefs in large areas of the world. Four hundred microbial rennets were prepared and studied for their possible use in cheese-making. Five emerged as potentially good rennet producers. An additional highlight of this study was the discovery that the phytic acid contained in wheat bran, a cheap agricultural by-product, greatly stimulates enzyme production. It is expected, as a result of this and related research, that bacterial rennets will eventually be produced industrially and that their use will lead to new domestic and export markets for cheese among groups with special food problems and prejudices.

Color formation in cured pork products. A uniform pink color in cured pork and hams is considered an important quality characteristic in modern meat marketing practices. Research conducted under a P. L. 480 grant in Great Britain is leading to a better understanding of the factors responsible for color irregularities in cured pork products. The research results are assisting to clarify the special roles of cellular constituents and enzyme systems in color production. In the more direct or technological approach, studies with muscle minces are revealing the effect of processing variables upon color formation. One of these findings applicable to commercial curing practices shows that although the initial rate of pigment conversion is slower at lower temperatures, the rate on prolonged incubation may be higher. Continued research along these lines is expected to define the optimum curing environment and to specify those meat enzymes essential to the development of good color in pork products.